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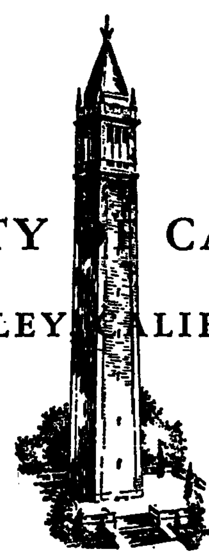

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ON OBSERVATIONS OF LUNAR MAGNETIC STORMS

Our understanding of geomagnetic phenomena can be furthered by information obtained with plasma detectors stationed on the moon. In this communication several types of magnetic disturbances are described in order to demonstrate possible differences between selenomagnetic and geomagnetic storms caused by identical solar events. The geomagnetic disturbances arise from the complex interaction of the solar plasma with the magnetosphere and from ring currents and hydromagnetic waves in the ionosphere. It is difficult, therefore, to sort out the various factors and primary events. On the assumption that the primary effects of the solar wind on the earth and the moon are analogous, correlated recordings of terrestrial magnetic fluctuations and of lunar plasma probes and magnetometers will separate the primary factors from the secondary effects due to the earth's environment.

Short of a circumsolar satellite a single lunar base provides the longest period of time, approximately one half the rotational period of the sun, during which a given solar event and its developments can be examined continuously and simultaneously by optical, radio- and magnetometric methods. Measurements and observations from the moon can, therefore, identify the causal relationships between specific solar events and magnetic storms at the earth-moon orbit. The term "magnetic storm" in the present context refers to any type of magnetic fluctuation, not necessarily one having a sudden commencement followed by a set of characteristic phases.

The gross features likely to dominate the environment of the moon may not be too dissimilar from those outside the earth's magnetosphere. In the absence of a permanent field, the surface functions as the lunar magnetopause. The fluctuations in motion, density and associated magnetic field intensity of the plasma in the vicinity of the moon may be comparable to those in the earth's magnetosheath(1). A weak lunar field of the order of 50 - 100 γ, which is not ruled out by either observational data or theoretical considerations(2), would not intercept the solar plasma beyond a fraction of a lunar radius above

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the subsolar surface(3). Using the criterion of equating the magnetic pressure of the lunar field with the static pressure of the solar wind due to its thermal motion we obtain an estimate that the wake might extend a selenocentric distance of about two lunar radii during quiescent solar periods. At times of enhanced solar activity, fluctuations formed in the shock front on the subsolar side are convected downstream and also affect the shape of the cavity. The fluctuations in the magnetic field can certainly be measured with presently available magnetometers.

A geomagnetic phenomenon whose origin is still in doubt after a half century of observation, namely, the semiannual variation of geomagnetic activity(4), can be clarified by lunar magnetic explorations. Two conflicting theories, the equinoctial(5) and the axial(6), attempt to explain it. According to the former the changes are seasonal ones which result from the annual variation of the direction of the earth's axis. According to the axial hypothesis the maxima and minima arise from the inclination of the sun's equator to the ecliptic at $\pm 7^{\circ}15'$. On the moon seasonal effects are negligible since the sun's selenographic latitude has an annual range of $\pm 1^{\circ}32'$ compared to the geographic latitudinal range of $\pm 23^{\circ}27'$. The axial variations ought to be the same on the moon because of the small inclination ($5^{\circ}8'$) of its orbital plane to the ecliptic. Therefore, no semiannual periodicity of magnetic disturbances ought to exist on the moon if the geomagnetic variations are seasonal effects. Detailed recordings of selenomagnetic storms will resolve this problem.

Aside from geomagnetic disturbances varying slowly with the eleven-year solar cycle, flare-driven, intense events are sporadic. On the moon the corresponding transients are likely to occur with the same spatial and temporal irregularities, as they are caused by one solar plasma stream whose cross-section may reach thousands of earth radii at the distance of 1 A.U. Although intense magnetic storms are probably moon-wide, their onset on the subsolar and antisolar sides may follow time sequences different from those on earth as these sequences tend to be secondary effects characteristic of the geomagnetic field. In the absence of a substantial self-field and an ionosphere, the antisolar side may be shielded from weak fluctuations in the solar wind. Therefore, the number of magnetic storms per year incident at a given point on the moon ought to be less than on earth, where most magnetic disturbances occur on a world-wide scale. For instance, two regions situated some 90^{o} east and west, respectively, of any but the central meridian, might not experience the same magnetic disturbances. A weak magnetic storm recorded on crater Copernicus might not register at mare Muscoviense.

The unique relations between the rotational periods of sun and moon can be applied advantageously to the study of M-region storms. These magnetic disturbances which have a tendency to recur at 27-day intervals may be sufficiently weak to affect the moon's subsolar side only. As a result of the near-synchronous motion of sun and moon, whose respective synodic periods are 27.3 and 29.5 days, the periodicity of these M-storms would then correspond to a slowly drifting selenographic position. Since the change in selenographic longitude is $360\,(1 - \frac{27.3}{29.5})$ degrees per solar rotation, M-storms may recur about 27n degrees east of a fixed location, where n denotes the number of successive solar rotations. A specific M-event would have to endure some seven solar rotations for every lunar feature to become exposed to the plasma stream associated with the same M-region. Since most active zones have life-times of less than seven solar revolutions, any given lunar region ought to be subjected to fewer M-storms per year than the earth.

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